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# NASA TECH BRIEF

*Langley Research Center*



## Investigation of Exit-Velocity Stratification Effects on Jets in a Crossflow (STRJET)

### The problem:

A fundamental problem in the development of methods for predicting aerodynamic characteristics of lift-jet, vector-thrust, and lift-fan V/STOL (Vertical/Short Takeoff and Landing) aircraft is that of formulating a mathematical model to estimate the effects of the propulsion system efflux interaction with a crossflow.

### The solution:

A considerable amount of research activity, both experimental and analytical, has been devoted to the development of an understanding of this flow problem and also to a computer program to calculate the resulting interference flow fields.

### How it's done:

A program has been developed for determining the flow field about jets with velocity stratification exhausting into a crossflow. Jets with three different types of exit-velocity stratification have been considered, namely: (a) jets with a relatively high-velocity core, (b) jets with a relatively low-velocity core, and (c) jets originating from a vaned nozzle.

The procedure developed for a jet originating from a high-velocity core nozzle is to construct an equivalent nozzle having the same mass flow and thrust but having a uniform exit-velocity profile. Calculations of the jet centerline and induced surface static pressures are shown to be in good agreement with test data for a high-velocity core nozzle. The equivalent ideal nozzle is also shown to be a good representation for jets with a relatively low-velocity core and for jets originating from a vaned nozzle, in evaluating jet-induced flow fields.

For the singular case of a low-velocity core nozzle, namely a nozzle with a dead air core, and for the vaned nozzle, an alternative procedure has been developed. The internal mixing which takes place in the jet core has been properly accounted for in the equations of motion governing the jet development. The calculations of jet centerlines and the induced surface static pressures showed good agreement with the test data for these nozzles.

A method for treating two-jet configurations has been extended to include mutual interference effects between the two jets, in addition to the jet blockage effects already considered. Comparisons have been made between the calculations and the test data for a number of jet configurations.

### Notes:

1. This program was written in FORTRAN IV for the CDC 6000-series computers.
2. Inquiries concerning this program should be directed to:

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